Required Quality Standards for Augmented Reality Applications*

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Abstract
A lot of research is being done by researchers to increase the quality of service in education and training. The fact that today's technology is advancing rapidly contributes to the whole field of life and undoubtedly contributes positively to education in many ways. In today's world where real life is moving rapidly as a necessity of technology age, it has begun to take its place in teaching programs in some applications. Augmented reality is one of the applications that especially researchers are trying to include in the field of education and its popularity has increased in recent years. Within the scope of the study, it was aimed to determine the quality standards that should be included in the augmented reality applications. Sequential exploratory mixed method was used in the research process. It is stated that this method which provides qualitative data for research problem by collecting and analyzing qualitative data and then forming quantitative data according to the obtained data will provide effective advantages in many aspects as well as being advantageous to researchers and also being used in scale development studies. In this context, a 5-point likert type scale called "Augmented Reality Quality Standards Scale (ARQSS)" was used as data collection tool. The sample of the study is composed of 350 science teachers and 60 faculty members working in Turkey. A number of analyzes have been conducted in order to ensure validity and reliability of the ARQSS in the course of development and it has been determined that the EFA outcome KMO coefficient is .857 and the Barlett Sphericity test $\chi 2$ is significant at 1741.20 ($p <.05$). In addition, the CFA results showed that the goodness of fit indexes obtained were RMSEA 0.047, GFI 0.88, CFI 0.95, and SRMR 0.049. As a result of the analysis, a scale with 2 factors and 20 items and a reliability coefficient Cronbach's Alpha 0.82 was developed. The application was made with the help of the developed scale and the quality standards that should be included in the applications of the Augmented Reality were determined taking the results obtained into consideration.
Keywords: Augmented Reality, Quality Standards, Science.

1. Introduction

A lot of research is being done by researchers to increase the quality of service in education and training. The fact that today's technology is advancing rapidly contributes to the whole field of life and undoubtedly contributes positively to education in many ways. In today's world where real life is moving rapidly as a necessity of technology age, it has begun to take its place in teaching programs in some applications. Augmented reality is one of the applications that especially researchers are trying to include in the field of education and its popularity has increased in recent years. Information and communication technologies (ICT) have become an ordinary part of our social and learning experiences today; digital learning environments and tools have emerged as tools that enrich the learning process. New technologies and approaches have been put into practice in order to make it possible to learn effectively and efficiently in the course of science teaching in the process of teaching 4 skills (doing, living, practicing, observing) and experimenting on three fields (mathematics, engineering and technology). One of these technologies started to use technologies which are known as augmented reality and which are defined in Turkish as enhanced, expanded or enriched reality expressions (Taşkıran, Koral & Bozkurt, 2015, Yılmaz, Gülgün & Çağlar, 2017).

While the lives of individuals are influenced by this rapid change process, it is not possible for the educational process and the educational environment to be affected by this change. When we look at the technologies used in the day-to-day educational environments, it is seen that blackboard and chalk are transforming towards intelligent technologies that have computer and internet world and even artificial intelligence. Especially in recent years, computer and internet technologies have had such a wide usage area in our lives that it is unthinkable for the education services to be excluded from that area (Bulun, Gülnar & Guran, 2004). The increase and diversification of the technologies that can be used in educational settings play an important role for educators to recognize these technologies and to use them effectively. For this reason, trainers should follow the technological developments and strive to use the most appropriate tools for their fields (Akkoyunlu, 2002; Erbas & Demirer, 2014). In recent years, the use of advanced real-world technologies in education has become widespread and the use of these technologies has become easier.

Augmented Reality

According to the definition made by Azuma (1997), the augmented reality is a variation of virtual environments. Virtual reality technologies put the user in an entirely artificial environment. In this artificial environment, the user can not see the real world around him. On the contrary, the augmented reality allows the user of the virtual world to see the real world, superimposed or merged onto the real world. For this reason, the augmented reality completes the reality instead of completely substituting reality (Azuma, 1997). According to another definition, increased reality is a series of technologies that integrate reality with digital technology (Berryman, 2012; Milgram & Kishino, 1994; Arslan & Elibol, 2015; Yılmaz, 2012, 2016). The new possibilities offered by augmented reality technology for teaching and learning have begun to attract the attention of educators over time. In particular, it appears that this technology can be used to create enriched training environments that are needed to provide real learning experiences where more than one sensory can be actively used (Luckin & Fraser, 2011). These environments can be used to learn through experience by enabling users to interact with virtual applications on the real world (Johnson, Smith, Willis, Levine & Haywood, 2011). The coexistence of virtual objects and real environments helps students to understand abstract concepts and complex spatial relationships. Augmented reality allows students to seamlessly apply learned knowledge and skills by combining learning environments with the real world they live in. In addition, students who are able to communicate face-to-face in the real environment of augmented reality have the opportunity to share their knowledge and experience within the group (Lave & Wenger, 1991; Yılmaz ve Bayrakçeken, 2015).

It is observed that the number of studies carried out in and out of the country regarding the use of the augmented reality in education has been increasing day by day. Comparative studies between increased realism-based practices and traditional classroom practices have shown that increased real-world technology enhances learners' learning (Freitas & Campos, 2008). Some researchers claim that increased realism, due to direct interaction with the educational material, leads to kinesthetic learning by internalizing body movements and senses with content (Seo, Kim & Kim, 2006; Gülgün, Yılmaz & Çağlar, 2017). Studies on the use of the augmented reality in education have also examined the effect of this technology on other elements that only support learning to learn and not learning. Cuendet, Bonnard, Do-Lenh & Dillenbourg (2013) have tried to show that augmented reality studies can be performed not only in the laboratory environment but also in the classroom environment, as they study the usability of the enhanced reality technology in the classroom environment. In the scope of the study, they have made adjustments in the classes of a high school level vocational education school in Switzerland and tested the applicability of the augmented reality applications in the classroom environment. The study showed that enhanced real-world technology could be used in class without interfering with other courses. Various studies are being done in our country on the augmented reality. Although it has been seen that the augmented reality studies carried out in our country are mostly carried out by engineers for product development, it is observed that the trainers have started to work on this field in recent years. Experts in our country are confronted as empirical studies on the work they have done on the augmented reality, the research of the area literature prepared for the introduction of this new technology and the use of the augmented reality applications in education (Çalık ve Sözbilir, 2014).

Çetinkaya & Akçay (2013) have dealt with the concept of augmented reality, the use of education and examples of practice in the work "Augmented reality applications in educational settings". As an example of experimental work carried out in our country on the application of the augmented reality in education, Abdüsselam & Karal (2012) can be considered as "The effect of enhanced reality environments in physics learning on students' academic achievement: Example of Class 11 Magnetism".

Augmented Reality (AR) applications that have become popular due to the innovations introduced by the age of technology in our country have not found the criteria and quality standards that should be found in an AR application in general, if there are some basic criteria about how to apply when the literature is examined. For this purpose, we aimed to determine the quality standards that should be included in our practice of augmented reality. Within this scope, in the scope of the study, the following questions were tried to be answered;

1. What are the quality standards that should be included in augmented reality (AR) applications?
2. What criteria should the augmented reality (AR) applications have?
3. Can augmented reality (AR) be applied to all areas if the application criteria are provide?

2. Method

In this study, an exploratory sequential mixed method of mixed research methods was used. The purpose of using this method is to explore the research problem first by exploring it with qualitative data collection and analysis. The second stage after this first stage involves the conversion of qualitative results into a new scale or the development of a new data collection tool or the creation of new intervention programs for the experiment. This second stage is followed by a third quantitative stage, which involves the application of scales, the testing of new data collection instruments, or the use of new intervention programs and their activities in the experiment. The method of research overlaps with the work we intend to do exactly. In this context, we can say that we made the right choice. In the execution of this pattern, the following steps are followed (Acar, 2017);

1. Qualitative data are collected and analyzed.
2. The results of qualitative analysis are examined. The qualitative results obtained are used to design the quantitative part consisting of components such as new scale and data collection tool development or new intervention examples.
3. The new quantitative structure is used and tested. This means that new scales are placed in the existing quantitative database. This may mean testing the new data collection tool for validity and reliability. It may also mean that the new component is used as part of an intervention program (or pre- and post-test) designed and included in an experimental study.
4. To ensure the feasibility of the intervention in the last step; it is reported how the new component (eg scales, data collection tools or activities) is developed through the available variables, how the current structure provides better conceptual measurement tools or provides additional useful activities. In addition, since the qualitative data is obtained from the small sample group in the first stage, testing the new quantitative component can give an idea of whether the qualitative results obtained in the first stage should be applied to a larger sample in the third quantitative stage.

What can be taken from qualitative results to facilitate these processes? Qualitative outcomes are composed of a collection of codes and codes formed by combining specific quotations from individuals, quotations, and quotations. When new scales are developed this way, the themes can be transformed into these scales or variables (Daugherty, 2009). When a new data collection tool is developed, the codes can be converted to theme scales or variables. When a new measuring tool is needed, the quotations can be transformed into test items, codes, variables and themes. To obtain new intervention activities aimed at the qualitative phase, these activities can be generated based on codes and themes. Another challenge of this design is the need to develop a new data collection tool based on qualitative results or to develop a good data collection tool with strong psychometric properties when the existing data collection tool is to be modified. There are many resources to develop a good scale and data collection tool (DeVellis, 2012; Acar, 2017). These steps are:

1. Compile the field text / consult the experts for advice.
2. We identify possible items (for scale).
3. You should pre-test the items using a small sample using descriptive factor analysis.
4. Perform reliability analyzes of the scales.
5. Apply a larger sample of the scale.
6. Perform confirmatory factor analysis on results.
7. Use the structural equation model to determine hidden variables.
8. You are looking for evidence of construction validity.

If we look at it positively, this pattern is meticulous and careful, making it a sophisticated hybrid method. In addition, this pattern is useful for underdeveloped countries (and global health surveys) because it is the low- feasibility of the scales from the western world, as it is the explorer of the first stage, and it is necessary for researchers to first discover which scales can be applied in the given environment. In addition, researchers who are familiar with qualitative research and who are good at qualitative research prefer this design because it begins with qualitative research (Acar, 2017).

The studies of the last 10 years, in which the in-depth literature review was conducted according to the research method explained in detail, were interviewed with field experts and the innovations in the field of technology were meticulously investigated and reported. After completing these steps that constitute the qualitative part of the work, the second stage, the quantitative step, was passed. At this stage, analyzes and numerical data are studied. Ultimately, a 5-point likert type scale was developed and applied and quality standards were set.

There are 350 science teachers and 60 faculty members who work in various ills and schools throughout Turkey. When determining the sample, appropriate sampling method is used. Because of the convenience of researchers, saving time and economy, it has been preferred as a priority. The improved reality quality standards scale, which is the data collection tool to be used in the quantitative and final part of the work, has been prepared and made ready for use through a series of processes. These processes can be briefly summarized as follows; In this context, it is necessary to design theoretical and conceptual infrastructure, to create a pool of substances, to apply to experts in the field, to make statistical analysis and to provide the reliability and validity (McMillan & Schumacher, 2006; Karasar, 2006).

Designing the Theoretical and Conceptual Infrastructure of ARQSS

In the course of designing the theoretical and conceptual infrastructure of ARQSS, a detailed field search was done. In the area type scan; (Kempa, 2002, Korkmaz, Şahin, & Yeşil, 2011 Öztürk, 2010, Walker, 2010, Yavuz, 2009; Yılmaz, Akyol & Kalgı, 2017) have been examined. As a result of field type examination, two main dimensions have emerged about quality standards. These; standards to be found in the application phase and standards for the materials used. These dimensions have been taken into consideration in determining the factors that may be included in the ARQSS scale and in naming the factors to be included in the scale by revealing the factor structure of the scale.

Creating an Item Pool

In the ARQSS 5 point likert type, teachers and faculty members' attitudes towards AR applications are structured as "Never Participate (1), Participate (2), Undecided (3), Participate (4), Participate Totally (5). A pool of substances with a draft ARQSS of 60 substances was established using the data obtained after the literature review.

Applying for Expert Persons in the Field

The draft ARQSSF scale has been reviewed by 8 faculty members to determine whether 60 items in the substance pool are suitable for raising attitudes towards quality standards for AR applications. When instructors were identified, it was taken into consideration that they should have worked in the field of scale development. Some of the lecturers were interviewed and one-on-one interviews were conducted.

Some of them were received via e-mail on the internet in terms of the shapes and contents of the materials, difficulties in expressions and questioning formats. Regarding the items in the measure, all the reviews and interviews made after the interviews were taken into account. In this way, the scope and appearance validity of the scale were tried to be provided (Fraenkel and Wallen, 2003). As a result of the expert opinion, draft ARQSS was formed as 35 items.

Pilot Implementation and Scale Arrangement

Pilot implementation of the ARQSS scale during the 2016 - 2017 academic year, a preliminary study was conducted with the participation of 200 teachers and 40 faculty members working in various fields of Turkey. This study aimed to understand how teachers and faculty members answered your scale. Following the implementation of the pilot, the scale, scale and general structure of the scale were made, and a 20-item scale with 2 factors was created.

Performing Statistical Analyzes to Ensure Validity and Reliability

The validity and reliability of the ARQSS scale is determined; item analysis, exploratory and confirmatory factor analysis, and Cronbach's Alpha Reliability coefficient calculations. The structure of a scale expresses how well the theoretical frame is in line with the items of the valid scale (Kane, 2001).

Factor analysis consists of two parts; exploratory and confirmatory. In the exploratory factor analysis, it is tried to determine the factors by way of the relations between the variables, whereas in the confirmatory factor analysis, it is aimed to test a hypothesis formed before the relation between the variables (Büyüköztürk, 2010). In the analysis of the ARQSS scale, SPSS 18.0 program and Lisrel 9.2 software programs were used in the analysis of the data.

For the reliability and validity analyzes, the scale was applied to a total of 200 teacher, 120 female and 80 male, and 25 female and 15 male faculty members. In the field, it is indicated that for the factor analysis, the number of samples should be at least 5 times (Tavşancıl, 2002). From this point of view, the sample seems to be sufficient.

3. Findings

The findings obtained as a result of the analysis are presented in an easy to understand structure; item analysis, suitability of the data for factor analysis, exploratory factor analysis, naming of the factors, confirmatory factor analysis and reliability analysis.

Item Analysis

Correlation values between each item and scale scores were determined for item analysis (Table 1). When the correlation values are examined, it is seen that these values change between 0,652 and 0,841 and * p <0,01 and ** Correlations are significant at 0,01 level.

In this method, which is used to select items for the scale, the difference between the mean score of the item scores of the scorers in the upper group and the item scores of the respondents in the sub-group was determined by t-test for independent groups.

Table 1. Item-Scale Correlations and Group Means t-test results

Item No	Item-Total Correlations	t- value of Sub/supergroup mean difference	Item No	Item-Total Correlations	t- value of Sub/supergroup mean difference
1	0,652**	7,788*	11	0,699**	8,841*
2	0,668**	8,967*	12	0,784**	11,186*
3	0,693**	11,668*	13	0,804**	12,579*
4	0,802**	12,123*	14	0,689**	9,138*
5	0,794**	11,045*	15	0,765**	10,412*
6	0,688**	8,714*	16	0,841**	13,342*
7	0,701**	8,995*	17	0,719**	9,280*
8	0,813**	10,124*	18	0,808**	12,876*
9	0,842**	11,524*	19	0,830**	12,762*
10	0,771**	9,107*	20	0,777**	11,301*

*p< 0,01 **Correlation 0,01 significance level

Suitability of the Data for Factor Analysis

Appropriateness of the data obtained after the application of the factor analysis is found by using the Kaiser- Meyer-Olkin (KMO) coefficient and the Bartlett test (Büyüköztürk, 2010). Significance of Bartlett test result is sufficient factor for factor analysis (Tabachnick & Fidel, 2007). The KMO coefficient value and the Bartlett test result are presented in Table 2.

Table 2. Suitability of the Data for Factor Analysis

KMO Coefficient		0,857
Bartlett test	Chi-square value	1741,20
	Sd	412
	p (p<0,05)	0,00

Exploratory Factor Analysis

After examining the suitability of the data for factor analysis, it was decided to decide how many different factors would be involved in the scale to be applied. At this stage, eigenvalue statistic and scree plot criteria were used. After this step, the varimax technique was used for the rotation of the factors and the steps of naming the factors were passed.

Table 3. Eigenvalue and Variance Statistics

Factor	Eigenvalue	Variance (%)	Cumulative %
1	2,741	40,63	40,63
2	1,203	20,10	60,73

Scale development studies generally take into consideration the factors 1 and 1, which are the essence values, when the number of factors is determined (Büyüköztürk, 2010). In the first analysis of the scale, it is seen that the factor is explained by two factors which are greater than 1. This is also seen when the scree plot graphic is examined (Figure 1). When the factor load values of the scale composed of 20 items are examined, it is seen that they have values between 0,487 and 0,802 (Table 4).

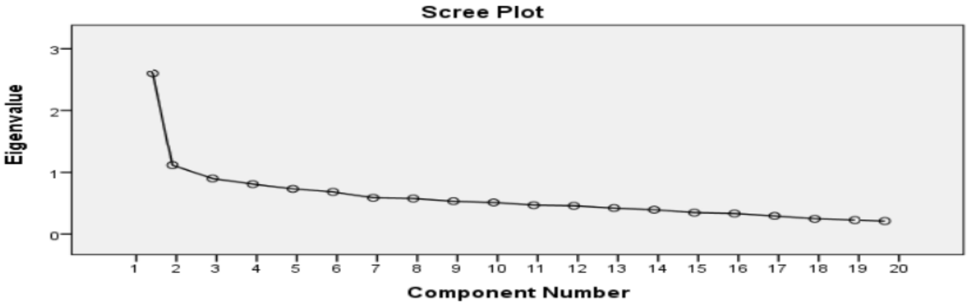

Figure 1. Scree plot graphic

Naming of the Factors

The ARQSS scale, which measures attitudes about quality standards that need to be found in augmented reality practices, appears to be composed of 2 factors as a result of exploratory factor analysis. Factors found in the scale; the standards that must be found in the application phase and the standards that must be found in the materials to be used.

Table 4. Item factor loads and Cronbach's Alpha Coefficient

Factors	Item No	Factor 1	Factor 2	Common factor variance	Cronbach's Alpha
Application Phase Standards	2	0,802		0,864	0,89
	13	0,799		0,840	
	1	0,767		0,806	
	15	0,752		0,784	
	7	0,735		0,753	
	3	0,707		0,731	
	9	0,693		0,688	
	18	0,674		0,641	
	20	0,668		0,606	
	11	0,660		0,597	
Material Standards	4		0,812	0,574	0,84
	17		0,799	0,571	
	8		0,782	0,567	
	12		0,739	0,564	
	5		0,689	0,562	
	14		0,633	0,557	
	19		0,578	0,546	
	6		0,564	0,536	
	16		0,530	0,507	
	10		0,487	0,496	
				Total Cronbach's Alpha	0,82

Confirmatory factor analysis

In order to determine accuracy levels of the factor structure of ARQSS confirmatory factor analysis is performed. To this purpose various goodness of fit statistics are used (Şimşek, 2007).

Table 5. Goodness of Fit Values

Analysis	X^2	X^2/df	RMSEA	RMR	SRMR	GFI	AGFI	NFI	CFI
First	803,40	3,45	0,063	0,056	0,057	0,82	0,83	0,91	0,91
Last	453,88	2,36	0,047	0,041	0,049	0,88	0,89	0,93	0,95

The values obtained by chi-square's ratio to the degree of freedom give information about the compatibility of the model. When Table 5 is examined, it is seen that the ratio of chi-squares to the degree of freedom is 2,36. A value of 3 or below this value indicates that the model is a good model (Sumer, 2000). Also, the fact that RMSEA, RMR and SRMR values are below 0.08 is a good fit for the model (Brown, 2006).

According to RMSEA, RMR and SRMR, we can say that the model has a good fit. GFI and AGFI values of 0.90 and above are a good fit. When NFI and CFI compliance index values are 0.90 and above, there is a good fit (Simsek, 2007). In the light of these values we can say that our scale has a good fit.

Reliability Analysis

The reliability coefficient of the scores obtained by the ARQSS scale (Cronbach's Alpha) was 0.89 for the items in the first group and 0.84 for the items in the second factor. For all dimensions of the scale, Cronbach's Alpha coefficient was calculated as 0,82. For reliability, Cronbach's alpha coefficient is greater than 0.80, indicating that the scores are reliable (Ho, 2006; Field, 2009).

4. Results, Conclusions and Recommendations

A total of 410 people have participated in the work to determine the quality standards that should be included in the augmented reality applications. 350 of them are teachers and 60 of them are faculty members. The participation of these people who work in various illusions and universities of Turkey is of great importance in terms of information diversity and sample richness. The study process started with qualitative research processes and then ended with quantitative research processes. Our research, which is a mixed research method study, can be characterized as a rich research in terms of both quantitative and qualitative stages.

The fact that today's technologies are moving at a very rapid pace and our educational life is adapting quickly, it also leads to the need to use these technologies correctly. Many schools and universities are working on AR applications. However, there are currently many guidelines that these applications should have and there is no standard. For this purpose, this work was required to complete this gap in the field. As a result of the study, a scale consisting of 2 factors and 20 items with validity and reliability was developed. This scale, prepared in 5-point likert type, will act as a guide for researchers who want to apply AR. In the light of this information, the following recommendations can be made by the researcher;

1. Developed AR applications can be tested on larger samples and other factors can be included in the process.
2. AR applications can be given special importance especially at the primary and secondary level.

References

Abdüsselam, M. S. & Karal, H. (2012). Fizik öğretiminde artırılmış gerçeklik ortamlarının öğrenci akademik başarısı üzerine etkisi: 11. Sınıf manyetizma konusu örneği. Eğitim ve Öğretim Araştırmaları Dergisi, 1(4), 170-181.

Acar, İ. H. (2017). Temel ve Gelişmiş Karma Yöntem Desenleri. M. Sözbilir, (Ed.), Karma Yöntem Araştırmalarına Giriş (1.Baskı) içinde 35-51. Ankara: PEGEM Akademi.

Akkoyunlu, B. (2002). Educational technology in Turkey: Past, present and future. Educational Media International, 39(2), 165-174.

Arslan, A. & Elibol, M. (2015). Analysis of educational augmented reality applications: The case of Android operating system. International Journal of Human Sciences, 12(2), 1792-1817. DOI:10.14687/ijhs.v12i2.3524

Azuma, R. T. (1997). A survey of augmented reality. Presence, 6(4), 355-385.

Berryman, D. R. (2012). Augmented Reality: A Review. Medical Reference Services Quarterly, 31(2), 212-218. DOI:10.1080/02763869.2012.670604

Brown, T. A. (2006). Confirmatory factor analysis: For applied research. New York: Guilford.

Bulun, M., Gülnar, B. & Güran, M. S. (2004). Eğitimde mobil teknolojiler. The Turkish Online Journal of Educational Technology, 3(2), 165-169.

Büyüköztürk, Ş. (2010). Sosyal bilimler için veri analizi el kitabı: İstatistik, araştırma deseni SPSS uygulamaları ve yorum (11. Baskı). Ankara: PegemA.

Cuendet, S., Bonnard, Q., Do-Lenh, S. & Dillenbourg, P. (2013). Designing augmented reality for the classroom.

Computers & Education, 68, 557-569.

Çetinkaya, H. H. & Akçay, M. (2013). Eğitim ortamlarında arttırılmış gerçeklik uygulamaları. Akademik Bilişim Konferansı, 23-25 Ocak 2013, Antalya: Akdeniz Üniversitesi.

Çalık, M. ve Sözbilir, M. (2014). İçerik analizinin parametreleri. Eğitim ve Bilim, 39(174), 33-38.

Daugherty, J. (2012). Infusing engineering concepts: Teaching engineering design. National Center for Engineering and Technology Education.

DeVellis, R. F. (2012). Scale development: Theory and applications (3rd ed.). Thousand Oaks, CA: SAGE.

Erbaş, Ç. & Demirer, V. (2014). Eğitimde artırılmış gerçeklik uygulamaları: Google glass örneği. Journal of Instructional Technologies & Teacher Education, 3(2), 8-16.
Field, A. (2009). Discovering statistics using SPSS (Third Ed.). London: SAGE
Fraenkel, J. R. &Wallen, N. E. (2003). How to design and evaluate research in education, (5th Ed.). New York: McGraw-Hill.
Freitas, R. & Campos, P. (2008). SMART: A system of augmented reality for teaching 2nd grade students. In Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction -Volume 2 (pp. 27-30). British Computer Society.
Gülgün, C., Yılmaz, A. & Çağlar, A. (2017). Teacher opinions about the qualities required in STEM activities applied in the science course. Journal of Current Researches on Social Sciences (JoCReSS), 7(1). 460-478.
Ho, R. (2006). Handbook of univariate and multivariate data analysis and interpretation with SPSS. Florida: Chapman ve Hall/CRC.
Johnson, L., Smith, R., Willis, H., Levine, A. & Haywood, K. (2011). The 2011 Horizon Report. Austin, Texas: The New Media Consortium.
Kane, M. T. (2001). Current concerns in validity theory. Journal of Educational Measurement, 38(4), 319-342. Karadayı-Taşkıran, A., Koral, E. & Bozkurt, A. (2015). Artırılmış gerçeklik uygulamasının yabancı dil öğretiminde kullanılması. Akademik Bilişim, 462-467.
Karasar, N. (2006). Bilimsel araştırma yöntemi (16.Baskı). Ankara: Nobel.
Kempa, R. (2002). Research and research utilization in chemical education. Chemistry Education: Research and Practice in Europe, 3(3), 327-343.
Korkmaz, Ö., Şahin, A. & Yeşil, R. (2011). Bilimsel araştırmaya yönelik tutum ölçeği geçerlilik ve güvenirlik çalışması. İlköğretim Online, 10(3), 961-973.
Lave, J. & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. NY: Cambridge University Press.
Luckin, R. & Fraser, D. S. (2011). Limitless or pointless? An evaluation of augmented reality technology in the school and home. International Journal of Technology Enhanced Learning, 3(5), 510-524.
McMillan, J. H. & Schumacher, S. (2006). Research in education: Evidence-based inquiry (sixth Ed.). Boston: Pearson.
Milgram, P. & Kishino, F. (1994). A Taxonomy of Mixed Reality Visual Displays. IEICE TRANSACTIONS on Information and Systems, 77(12), 1321-1329.
Özturk, M. A. (2010). An exploratory study on measuring educators' attitudes toward educational research. Educational Research and Reviews, 5(12), 758-769.
Seo, J., Kim, N. & Kim, G. J. (2006). Designing interactions for augmented reality based educational contents.
Technologies for E-Learning and Digital Entertainment, 1188-1197. DOI: 10.1007/11736639_149. Sümer, N. (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar. Türk Psikoloji Yazıları, 3(6), 49-74. Şimşek, Ö. F. (2007). Yapısal eşitlik modellemesine giriş: Temel ilkeler ve LISREL uygulamaları. Ankara: Ekinoks Tabachnick, B. G. & Fidell, L. S. (2007). Using multivariate statistics (5th Ed.). Boston: Allyn ve Bacon. Tavşancıl, E. (2006). Tutumların ölçülmesi ve SPSS ile veri analizi (3.Baskı). Ankara: Nobel.
Walker, D. A. (2010). The attitudes toward research scale. Multiple Linear Regression Viewpoints, 36(1), 18-26. Yavuz, M. (2009). Eğitim araştırmaları ile ilgili öğretmen ve yönetici görüşlerinin analizi. Selçuk Üniversitesi
Ahmet Keleşoğlu Eğitim Fakültesi Dergisi, 27, 143-158.
Yılmaz, A. (2012). Öğretmen Adaylarının Elektrokimya Konusunda Anlayışlarının Belirlenmesi. Yayınlanmış Yüksek Lisans Tezi, Atatürk Üniversitesi Eğitim Bilimleri Enstitüsü, Erzurum.
Yılmaz, A. (2016). Approaches towards to higher education quality and accreditation: A meta-analysis application made up until 2016 year. Journal of Current Researches on Social Sciences (JoCReSS), 6(1), 33-54.
Yılmaz, A., Ertuğrul-Akyol, B. & Kalgı, E. (2017). Required professional competency and quality standards of newly appointed science teachers. Journal of Strategic Research in Social Science (JoSReSS),3(2).242-256.
Yılmaz, A. & Bayrakçeken, S. (2015). Determining of the prospective teachers' understadings of electrochemistry. International Conference On New Horizons In Education (INTE 2014), Procedia-Social and Behavioral Sciences, 174(2015), 2831-2838. Online[http://www.sciencedirect.com/science/article/pii/S1877042815010344]. DOI:10.1016/j.sbspro.2015.01.975
Yılmaz, A., Gülgün, C. & Çağlar, A. (2017). Teaching with STEM applications for 7th class students unit of

"Force and Energy": Let's make a parachute, water jet, catapult, intelligent curtain and hydraulic work machine (bucket machine) activities. Journal of Current Researches on Educational Studies (JoCuRES), 7(1). 98-116.

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